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Tekn. dr Fredrik Ljungström*: The Shale Oil Question - Old
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*Fiskebäckskil, Sweden

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Translated from Swedish by the Ralph McElroy Co., Custom Division
2102 Rio Grande, Austin, Texas 78705 USA

THE SHALE OIL QUESTION - OLD AND NEW VIEWPOINTS

The methods developed during the past decade within the Svenska Skifferolje AB for production of shale oil and other products, can be divided into two groups: mining methods and oil production *in situ*. During the operation of the company, the first-mentioned has gained the wholehearted support of the government, which is encouraging, since the production of liquid fuels from the country's own resources is of utmost importance.

Due to unfavorable natural circumstances, however, it has not been possible to give the youngest and newest method, production *in situ*, a corresponding opportunity to develop. This method, electrothermic shale oil production, was not perfected until after Skifferoljebolaget was founded. Mining methods, in various forms, were already in existence before the mineral oil industry as a whole had reached its current position of wide importance. (In Scotland, shale oil was produced before any other mineral oil had become commonly used.)

Years of extreme water shortage have made the application of the electrothermic method *in situ* more difficult and, which is worse, indirectly stopped the development of this method during a succession of years. During the first postwar period, oil flowed into our country from all directions. Oil naturally found its way to locations where money was available at the time. Demands for continued operation of the electrothermic method were therefore placed in an even more unfavorable light, and it became impossible to continue the developmental work, which until then, had received so much

encouragement from the State Power Board. Finally, in spite of very favorable results with the method, little hope remained that it would be developed further.

It was, therefore, not unexpected that I, as the initiator, should look for other means of producing oil *in situ* where the dependence on the country's water power would be less apparent and where the principle of self-support would be applied. Several years ago, I therefore tried to get one of the country's large industrial corporations interested in manufacturing oxygen on a larger scale. This was for the express purpose of applying a development started abroad to shale in which carbon is vaporized by oxygen (Tekn. T. 1949, p. 842, 1950, p. 222).

In Kvarntorp, the electrothermic method (also called the Ljungström method) is slated for resumption in 1953, Figure 1, after which water power can be connected gradually so that approximately 20 MW can finally be added to the plant in 1958. It may be forgiven, if this development program is not too stimulating for the 75 year old initiator although, at the same time, it is a satisfaction for him to see that his initiative again will be of use and thereby is expected to improve the economy of Skifferoljebolaget considerably.

Experiences from the operation at Kvarntorp

At the now discontinued operation at the Norrtorp 2 field, Figure 2, the input of electrical energy during some years came close to an average of 20 MW, divided onto two with 10 MW in each. A total of 70,000 m³ of oil was produced there.

Figure 3 shows statistics of the operation during this period. The electrical heating started, as a matter of fact, under the worst imaginable conditions. It was of importance to produce the oil as rapidly as possible, and my wish to start the extraction by half a year's draining of the subsoil water could not be applied. The energy consumption numbers

shown in the diagram, therefore, also include vaporization of a large excess of water. This could have been removed much more cheaply if the time schedule would have allowed it.

The operation method included a whole series of temperatures measured in vertical holes whereby the increase in temperature in the shale layers during the influence of the progressing electrothermic front could be read. Figure 4 shows the gradual heating in a certain front position at different times and includes simultaneous electrical energy input information.

The top graphs are examples from one location in the shale oil field where only slight water invasion damage had occurred. From this and a number of similar graphs, information was received which allowed the determination of the best result that could be expected with good ground drainage. The graphs in the bottom diagram show poor results obtained when the increase in temperature was severely counteracted by water in the shale layers.

The operation statistics in Figure 3 comprise the whole plant and are the basis for calculation of the energy consumption per liter of oil. This is graphically shown in Figure 5. As can be seen, approximately two-thirds of the electrical energy is needed in this case to heat the shale rock to pyrolysis temperature. After reaching this temperature (between 300° and 360°), the actual pyrolysis is performed with consumption of a third of the total amount of energy. No cleanup of the records has been made. The numbers in the operational statistics have been used unchanged, making no discount for the continuous improvements introduced during the application of the method.

Figure 6 shows the consumption of energy per liter of oil at the four dimensions of the plant which have been used. The highest consumption is based on statistics from a six-hole group. The next point was obtained at an input of approximately

400 kW in the first small experimental field which was only 18 x 12 m. 75m³ of oil was produced here with the first experimental apparatus. One barrel of this oil was donated to the farmer who owned the experimental grounds, and this crude oil was of such a high quality that it could be used directly without refining in the farm tractor during spring plowing. The whole plant, including engineering work and all other expenses, amounted to 70,000 Skr. The farmers in the area wanted to buy the oil for 2 Skr/l for the spring plowing. If the oil, as well as the generator gas, had been available for personal use, this first experimental plant would have shown an immediate return of 100% and would have been completely paid off.

To return to the consumption diagram, the third point, Norrortorp I, shows the energy consumption at a 3 MW front, and finally the fourth point shows the 10,000 kW consumption at the above-mentioned Norrortorp 2 field. The asymptote to which the curve is advancing is based on the temperature curves in Figure 4. For the future support of the country with liquid fuel, especially gasoline, during critical situations, it would have been of great value to be able to determine the fifth point. This was attempted by the proposed application of an input of 30 MW on one front during operation of the plant in question. Unfortunately, completion of the operation (which meant an increase to 30 MW for which almost all of the equipment was complete) could not be carried through before the aggravated power situation prevented it.

The knowledge which has been gained about energy consumption per liter of oil produced is, therefore, limited to a plant capacity corresponding to a 10 MW input in one front. A change from two fronts of 10 MW each into one front of 30 MW was going on at the time of the operation reduction. The principal

reason why two fronts had been chosen was, because this arrangement allowed production of oil with the shortest delay, and consideration had to be given to the fact that the field, at the onset of energy, was drenched in water.

The two fronts were standing back-to-back at the onset, thereby providing the greatest chance to prevent a water invasion. Later, when the fronts were separated some hundred meters, this arrangement was very unfavorable, and that is why a change to a collected unit front was started.

Within the frame for this short communication, the economy of electrothermic shale oil production cannot be examined. It will suffice to say that, with today's oil prices, the results already obtained show that gasoline and oil can be produced with economically satisfying results based on a water power price for high voltage water power at Hallsberg of 1.3 öre/kWh.

It is the opinion of the leaders, however, that water power should not be used to any larger extent for this purpose and that production methods which are self-supporting in respect to water power are to be preferred. With knowledge of this fact, it is natural that an enthusiastic effort has been mounted to develop the *in situ* method. Among the ways to reach this goal, that have been studied, the use of oxygen appears, at the present time to be the most workable solution.

The experiences with the electrothermic production method which were mentioned briefly above have built a platform onto which a more extensive research structure can be erected. This, especailly for Sweden, would be of utmost value. The grass should not be left to grow on this platform as it literally has done for several years at Kvarntorp. For these reasons, therefore, I here dare to express my fantasies of a further development of the methods *in situ*.

Preliminary vaporization experiments *in situ*

In connection to this subject, I will describe some experiments that shed light on the possibilities that exist. Figure 7 shows a section of the shale rock in the first small experimental field at Östersäter. To study the characteristics of the shale layers in regard to the intended degassing *in situ*, two holes 18 meters apart were drilled down to a depth of 6 meters. A pipe for compressed air was lowered into the left hole and sealed off. Air could thereby be led into the rock to a depth of 6 m. A probe was inserted into the other hole. It rested on the bottom of the hole and was connected to a dial test indicator oriented and connected to the top of the ground. Compressed air was then led in via a small air compressor, and a pressure of 2 atmospheres was forced into the rock. The air, together with existing subsoil water, flowed through the right hole like a geyser. The dial test indicator registered a rise of the ground surface of 1.5 mm; it was made clear by the experiment that the ground surface in the area more or less had been lifted by the compressed air.

When the air infusion was halted, the ground sank slowly back to its original level but, even the next day, an overpressure of about 0.3 atm remained in the rock. The experiment showed that at a pressure equivalent to the weight of the rock mass per unit of surface, the shale rock is splitting horizontally and, in this way, becomes available for gas distribution within large areas. It was later observed at the Ljungström field that gas and oil can spread in smaller quantities in the horizontal layers to a distance from the plant of several hundred meters. In the first laboratory experiment, rock was substituted by a large piece of shale and showed how shale (during the very slow heating which is involved in the *in situ*

method) flakes up in very thin layers similar to a stack of papers. This property of shale is of importance for gas production *in situ*.

Figure 8 shows the Ljungström field No. 1 on Norrtorp at Kvarntorp. The field has a front width of approximately 70 m. After degassing the largest portion of this field, an air compressor was placed within the dotted circular line and, during a one-month period, forced down approximately 250,000 m³ air into the remaining porous shale coke. Gas analysis from the area showed the existence of sulfur dioxide and carbon dioxide, but the nitrogen which had been pumped in was not found in the analysis nor could it be recorded by the gas meter set up in connection with the ongoing production of shale oil gas where it should have been clearly recordable.

A possible explanation is that ammonia synthesis occurred in the large porous mass of remaining shale coke (approximately 100,000 m³) but, at the existing temperatures, not more than 3% of the nitrogen should have been converted to ammonia. It is possible that this could continuously be dissolved in the moist surface layers surrounding the coke body, but this could not be confirmed by analysis of the subsoil water pumped from the surrounding area of the plant or of the water condensate from the pyrolysis. The latter did not show an increased amount of ammonia. The experiment shows, however, that interesting possibilities exist for the conduction of chemical processes in a catalyzer of gigantic proportions, which a rock of porous shale coke is.

The following table shows the result of vaporization of carbon with oxygen at different temperatures:

Combustion temperature °C	The gas mixture's	
	CO-content %	Thermal value kcal/m ³
500	9	271
600	31	531
700	63	1,890
800	88	2,649
900	98	2,950
1,000	99.4	2,992

From this it should be noted that only a minute part of the gas is obtained in the form of CO at a temperature of 500°C and that, as is known, the CO content increases with increasing temperature to a maximum at 1000°C. The equilibrium between CO and CO₂ at different temperatures is a determining factor in the vaporization of a shale rock.

Figure 9 shows the course of the endothermic process during the heating of shale which has approximately a 6% oil content. In connection with the graphs presented, it should be noted that combustion with oxygen has begun by 250°C and in its relation to combustion to CO₂, it can be completed at 500°C. The graph shows three periods when heat consumption is increased. The first occurs at degassing of the water present in the pores of the shale (between 100° and 150°C). The second occurs at pyrolysis, i.e. at the conversion of the bituminous substances of the shale into different liquid or gaseous hydrocarbons (300°-400°C). The third and largest period occurs when the clay water bound in the shale ash is forced out (500°-600°C).

As shown by the graph, heat consumption rises rapidly at 500°; for an economical pyrolysis of shale, one should not exceed this temperature. During oil production in situ

the economical temperature limit has proven to be around 400°. The energy fed in beyond that point seems to be totally wasted.

Suggestions for Swedish gas production *in situ*

Sweden's incomparably largest fuel stock is in Östergötland, but the oil shale stored there is poorer in oil than the Närke shale and contains an average of 4% oil as compared to 6% in the richer Närke stocks. Furthermore, the shale here (Östergötland ?) is lying under mightly layers of lime, which could make its mining on a larger scale utterly uneconomical while, in addition, the mightly overlying lime rock makes extraction by the electro-thermic method less attractive.

In certain places in Östergötland, small quantities of escaping gas have been observed during drilling. These gases, however, have soon been exhausted. This shows that a small quantity of gas from time immemorial is stored under pressure in the shale layer or other formations under the overlying lime rock. The thicker the covering layer of lime rock, the tighter it seals the gas under pressure, an observation which has been confirmed during oil production in the Ljungström field at Norrtrorp where a lime rock cover from 1.5-10 m thick over the shale layers has been drilled through. A lime rock cover of 5-15 m thickness is the most feasible in this production method.

The Östgöta shale, due to its lower oil content, shows physical and chemical properties which should be especially advantageous for degassing with the assistance of oxygen. The higher has content (approximately 75%) shows that, after degassing, a shell remains in the rock and forms a porous, gas-permeable structure of greater stability than that from the richer shale. (At the Ljungström field, the ground level sinks approximately 1/2 m during degassing, showing that even here a shell

remains which, in spite of the compression, has porous structure).

During compression and sinking, minor displacements in the rock mass naturally occur. This is catastrophic in coal mines or beds of coal but, in the poorer shale rock, it allows for a residual, arranged porosity. Here one finds the basic difference in the physical conditions for degassing *in situ* between the ongoing experiments in many areas abroad for degassing of coal beds and the proposed degassing of the poorer shales of Östergötland.

The reason that they have obtained rather poor gas abroad by degassing *in situ* with oxygen is that they have met with great difficulties when trying to direct the process of combustion. At the high temperatures that have to be used for vaporization of carbon into CO, combustion cannot be controlled, and the result is an excessive addition of carbon dioxide and possibly other diluted gases. I have, therefore, thought that vaporization in shale rock should preferably take place at low temperatures, whereby the heat created by combustion of shale coke to CO₂ can be distributed suitably due to the organized porosity of the rock, which allows the process to spread at a slow rate within large areas.

The electrothermic method has already shown that gas flows within the shale rock can be directed as desired, and that knowledge will be useful in experiments or *in situ* combustion with oxygen.

It should be noted that the sudden increase of heat consumption at temperatures above 500° shown in Figure 9 has a strongly stabilizing effect on the combustion since heat production is decreased simultaneously with the combustion into CO. One can therefore expect that the difficulties that occur during experimentation to find suitable applications for vaporization of shale with oxygen, will be of the same benign

nature as the ones that have been conquered during the experiments with the electrothermic process.

When I tried to initiate experiments with oxygen some years ago, there was no major apparatus for the production of the gas in this country. Since then, the production of oxygen abroad has been further developed and, based on the information received, a major plant for oxygen production will be built in this country in connection with the iron industry. Interest in the use of oxygen in different areas has thereby been further realized, especially since it has been possible to reduce the power consumption to only 0.4 kWh/m^3 of oxygen, if the demand for its purity is not placed too high.

I have been told that the cost of oxygen production amounts to approximately 3.5 öre/m^3 including power and all other expenses. If, as in this case, the fuel for the power generation in a steam producer is locally available, maybe the price could be estimated at 3 öre/m^3 .

In the overview given above of the heat requirement for heating shale rock, this requirement is well-known from the electrothermic process. By application of this heat requirement on the poorer Östgöta shale, the combustion heat from exhausted hydrocarbons per m^3 of oxygen fed can be calculated. It should be noted that this calculation is based on the data which, in spite of inrunning water and all other disgusting circumstances, have proven to exist in electrothermic shale oil production. The data should, therefore, give a good view of the possibilities in the area.

The following table illustrates the energy balance for the Östgöta project based on the condition of an ingoing thermal value for the shale of 1600 kcal/kg :

	Electrothermic method	Combustion method	Vaporization method
Maximum temperature	100	500	900
From 0.4 kWh is obtained	44 kcal	10 m ³ O ₂	10 m ³ O ₂
Pyrolyzed shale	2.5	32.5	9.0
Produced oil	0.055	0.62	0.17
Produced crude gas	15	620	170
Produced CO-gas	1	—	2000
Obtained calories	1000	11000	9000
	kcal kg	1000	900

The sulphur is included in the thermal value
for both pyrolysis gases and coke.

From the table, it is evident that per m³ of infed oxygen, hydrocarbons (gas and oil) with a combined combustion value of 11,000 kcal can be obtained, whereas vaporization of the coke also (if it would be possible to perform) would leave a poorer result of 9,000 kcal.

Figure 10 shows a map of the shale field in Östergötland. Below the lime rock there are close to 500 km² of oilbearing shale with a thickness of approximately 15 m, from which, depending on the completion of the process, hydrocarbons representing an oil quantity of over 1 billion m³ of oil can be extracted.

It seems to me to be of great importance for the fuel support of our country that research in the area of combustion *in situ* not be left unconsidered any longer as the case has been in connection with the forced discontinuance of energy production from the Ljungström field in Norrtorp. This phase of fuel research should be given the same strong support which has been given to other methods for shale oil production.

The future prospects of nuclear energy

L. Kowarski, technical director of Commissariat à l'Energie Atomique in Paris, exposed his views on the position of nuclear energy work in the world in a lecture in May 1950. Even if it contains nothing basically new, his viewpoints are fresh, in many cases original, and seldom uninteresting. The number of nuclear reactors in USA can be estimated at around ten, two in Canada, two in Great Britain aside from two under construction, and one in France plus one recently started, to which are added an unknown number in Russia. Of these reactors, those producing plutonium in Hanford are cooled with water, i.e. the temperature does not exceed 100°C, while in other reactors the heat development occurs at a temperature of 200-300°C.

In the first case, the temperature is too low for the energy development to be useful for practical purposes; in the latter case, it would be conceivable to use the released energy at least for heating the laboratories in the neighborhood of the reactor. However, the designers of the reactors have enough problems, and so far even large nuclear centers have been heated using conventional methods.

The main reason nuclear work receives encouragement in practically all countries might be the military interest in nuclear weapons and nuclear energy. But in the reactor production of plutonium, the explosive material in an atom bomb, one allows this process to run at as low a temperature as possible in order not to unnecessarily complicate the process. In non-military applications, however, one wants a high temperature in the reactors which then have to be cooled with, for instance, liquid metal, a complication which the plutonium manufacturer would prefer to avoid. For both the military and non-military use of nuclear energy, it is of course of greatest importance to construct a regenerative reactor in which more plutonium or

uranium 233 is produced than what is used of uranium 235. The work performed in the USA on the construction of a reactor for submarine operation is naturally of great interest for similar civil purposes also.

In a relatively short period of time, the Americans have concentrated on more advanced problems in reactor techniques, including among others the construction of different types of regenerative reactors. In Great Britain, the military needs have been given a lesser degree of priority, and American progress is, therefore, less marked when it concerns non-military applications. The French input is, from both a budget and personnel standpoint, 10 times less than the English and 100 times less than the American. There are now about twenty persons in France who can operate a reactor, and the advance of the French nuclear energy work depends to a high degree on this cadre. The French reactor under construction will make France self-supporting with radioactive isotopes. In this area, the American paper bureaucracy is by the way as pronounced as the British procedure is smooth and rapid.

The time for production of nuclear energy for non-military purposes will depend entirely on the international situation and the degree of cooperation that can be established between the industrialized countries of the world. At the present time, this cooperation hardly exists at all. Each country is working separately and places a seal of secrecy on its results. A formal exception exists: between the USA, Canada, and England there is a collaboration agreement, which was reached during the war and has since been renewed. But in practice, it is not of great importance; the amount of information circulating between the three nations is insignificant, and the trust is disturbed by episodes like the Fuchs affair. From what is known, Russia already has nuclear weapons. In spite of this, the Americans continue to observe a rigorous secrecy not only

of certain technical data, but also of a multitude of facts of a purely scientific nature. As long as this politic is maintained, it is highly unlikely that a cooperation of any kind can be built between the USA and the rest of the world in the area of non-military nuclear energy research.

It is natural that under such conditions France, though has occurred of a supervisory national organization in western Europe in the area of non-military nuclear energy research. Within such an organization, one would first build a simple reactor of the same type as the present French (or the future Norwegian) and thereafter build a larger reactor as, for instance, the one in Brookhaven. Then one would try to develop projects with a direct connection to the problem of using nuclear energy for non-military purposes. Such a cooperation between the western European nations meets, however, with many obstacles. One of them is the hope which is held by most of the nations of preferential treatment on the part of the USA. Due to the extent of the resources which are available for nuclear energy research in the USA and Great Britain, these countries do not suffer a great disadvantage under present conditions but, for other countries, it means that they hardly can make any important contributions in realizing a non-military use of nuclear energy.

In the future, nuclear energy can be of great importance for areas such as Canada, central Australia, and the Sahara. In the latter case, for instance, it could be for production of fresh water through distillation (although one thinks that it would be more obvious in that case to use solar power directly).

By the year 1960, the first nuclear energy plants for non-military use should be completed. These plants should be economically motivated in certain areas, for example central Australia and the Sahara. By 1975, one should have advanced

so far that nuclear plants would be discussed as alternatives along with hydroelectric and coal power stations. Near the turn of the century in the year 2000, the new power source should have won over the classical, and one should have converted to using uranium in, for instance, the granites. One ton of granite is equivalent to 30 tons of coal. Thereafter, a heat calorie should be as easily accessible as water, which, in most of the civilized nations, is freely available. One should, however, keep in mind that there are energy sources other than the ones represented by the uranium deposits: the power of waves and wind, solar energy, etc., which may start playing as large a role as nuclear energy.

In a world where energy is as easily accessible as water, the human contribution changes character. Work produced through muscle will then be of even less importance than in today's highest civilized centers, and the human activity, to a much greater extent than today, will consist of making choices and decisions according to the information our senses give us and the interpretations our brain makes (L. Kowarski in Econ. appl. 1950, p. 207).

The half-life for C^{14} has been estimated at different values between 4700 and 7200 years. The determinations have consequently been so uncertain that it has not been possible to use C^{14} as a radioactive standard. CO^{60} has therefore been used, in spite of its relatively short half-life. This isotope is certainly satisfactory as a standard for elements with similar radiation, but it is unsuitable as a standard for C^{14} .

G. G. Manow at AEC has now determined the half-life of C^{14} to be 5360 ± 100 years, which is considered precise enough for the isotope to be used as a primary standard. AEC manufactures plates of C^{14} containing polystyrene that are intended for calibration of instruments used in measuring radiation. (Ind. Engng. Chem., Oct. 1950).

Plutonium found in nature

Microgram amounts of Pu^{239} have been found in waste liquid obtained during the extraction of uranium from pitchblende originating in the Belgian Congo. Pu^{238} and isotopes heavier than Pu^{239} have also been found; the content of the former is less than 0.0003% and of the latter less than 1% of the Pu^{239} content. It is believed that nuclear reactions similar to those that occur in a uranium reactor occur in ore layers, i.e. splitting and absorption of neutrons in U^{238} . But it is also conceivable that a part of Pu^{239} is a link in a not-yet-discovered radioactive series (Nucleonics, Oct. 1950).

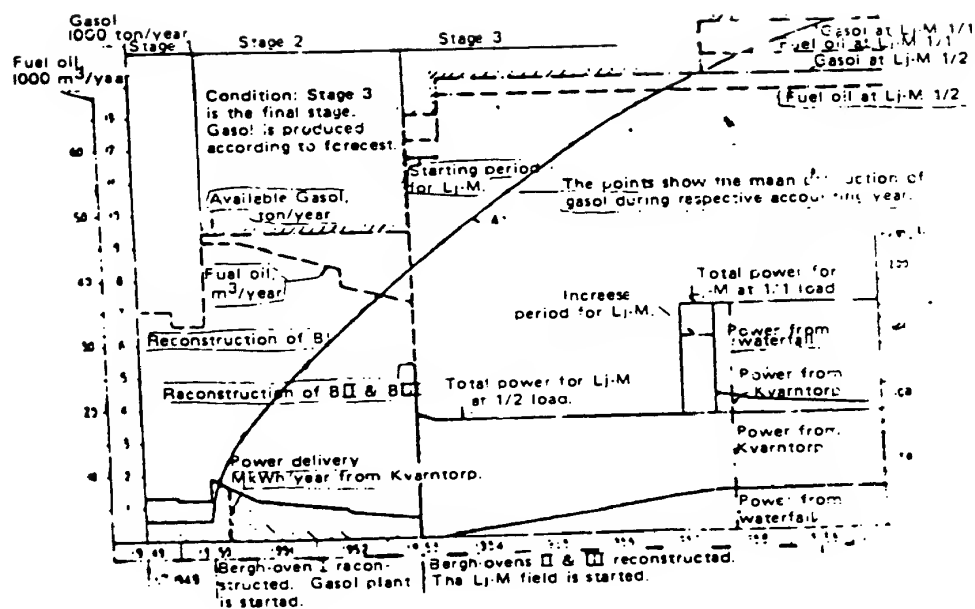


Figure 1. Time plan for the Ljungström method.

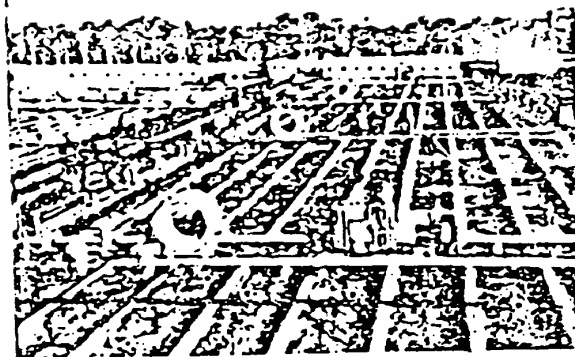


Figure 2. The Norrtorp 2 field where 70,000³ Ljungström oil have been extracted.

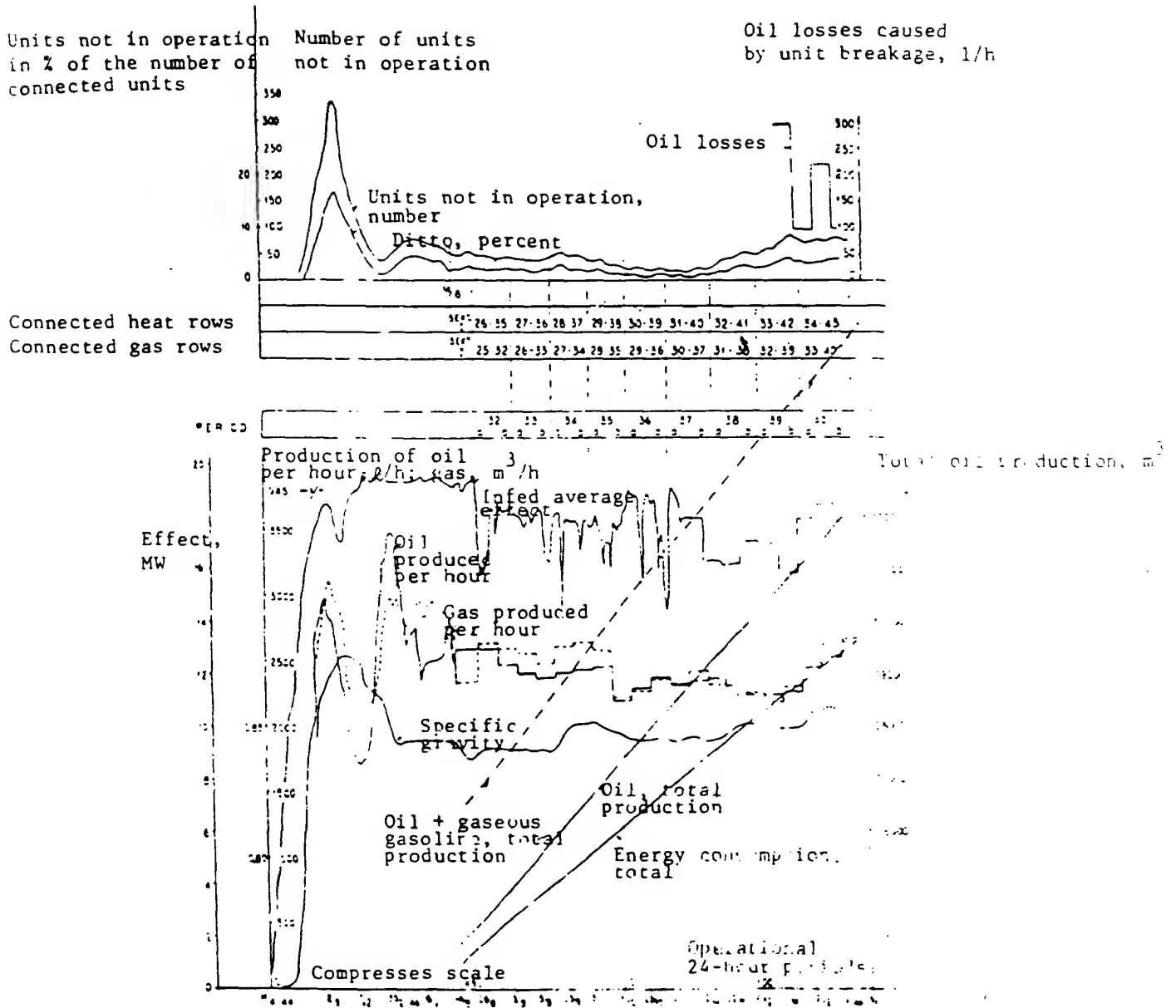


Figure 3. Operation statistics from 1960 to 1962

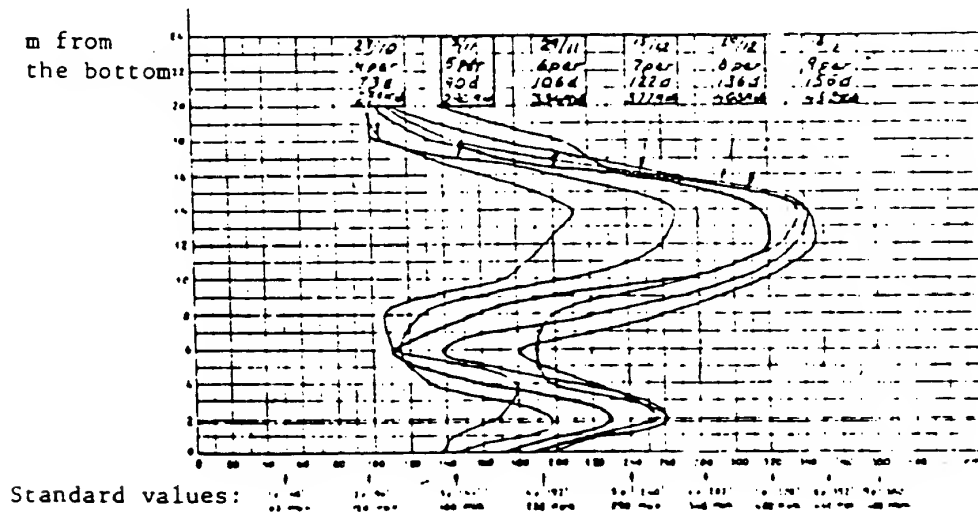
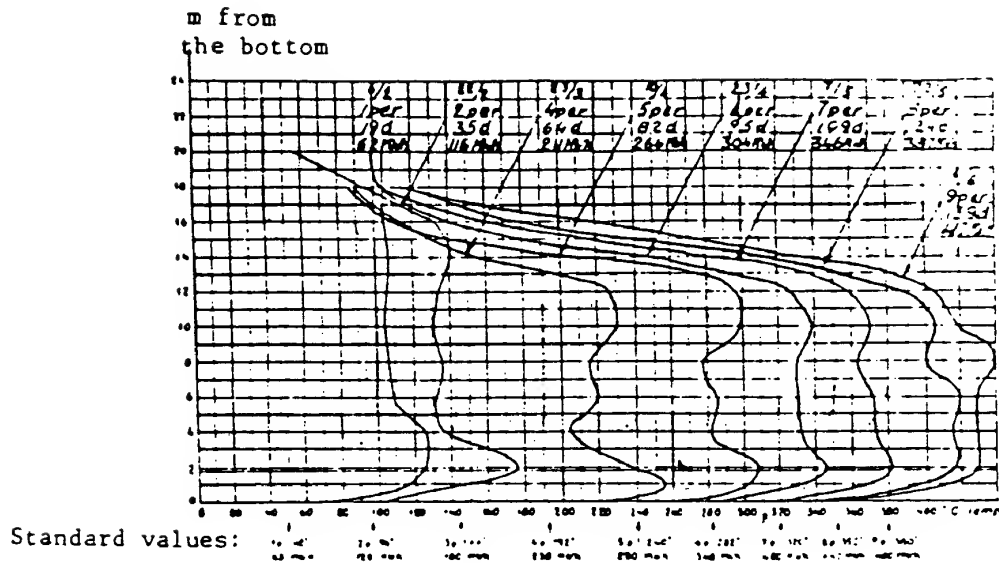


Figure 4. Gradual heating at different times after the connection; lower graph, during counteraction by water.

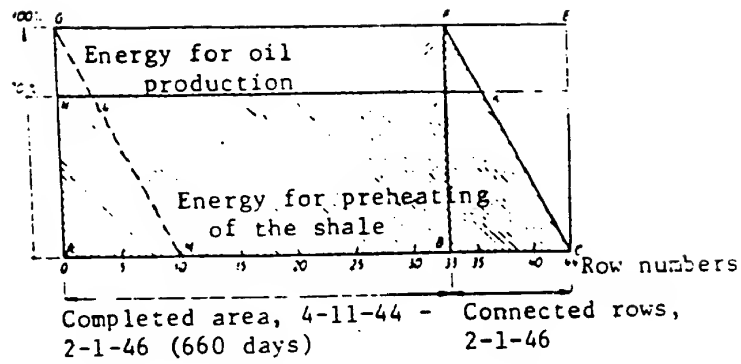


Figure 5. Energy availability per liter of oil.

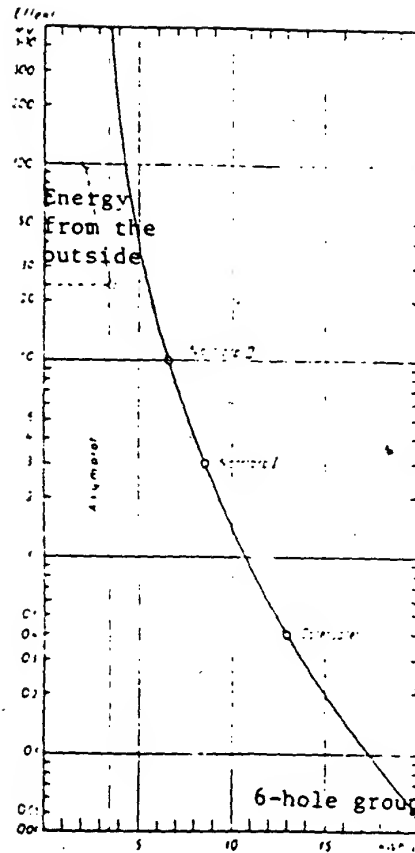


Figure 6. Energy consumption per liter of oil at different plant dimensions.

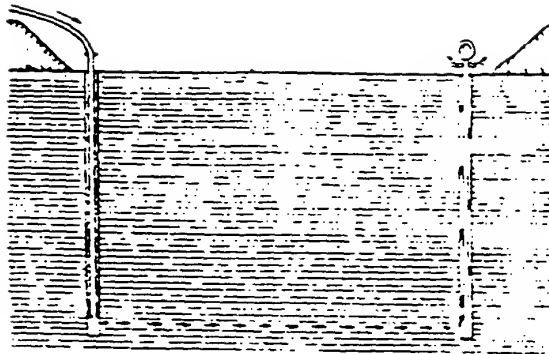


Figure 7. A section of the shale rock in the first experimental field at Östersäter.

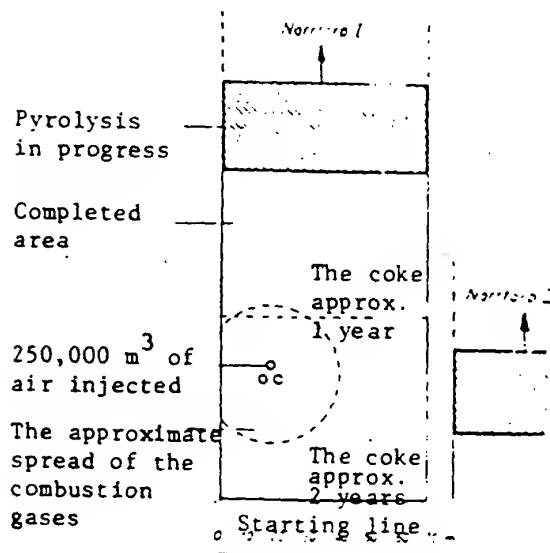


Figure 8. Experiments with air injection at the Ljungström field Norrtorp 1.

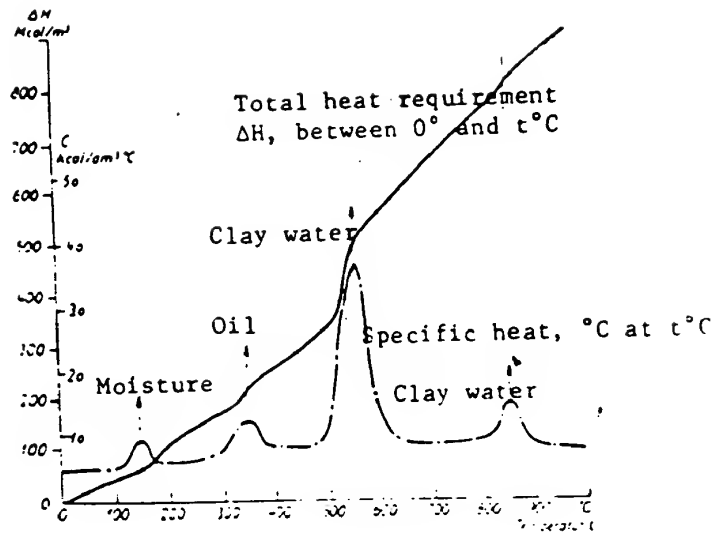


Figure 9. Endothermic process during heating of sand with 6% oil content.

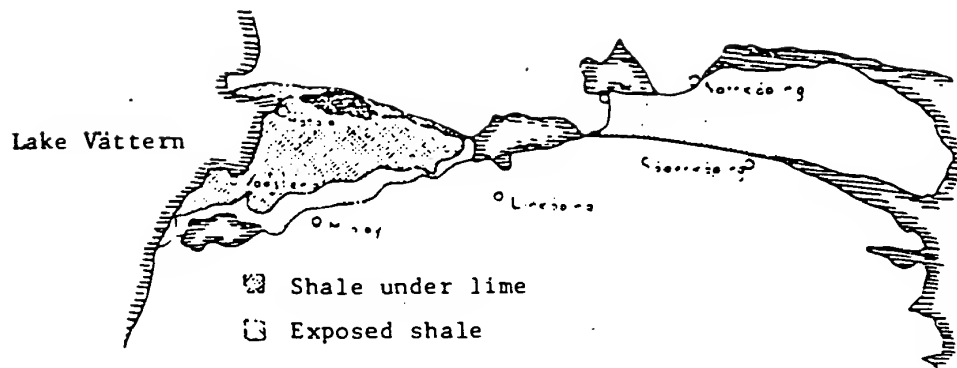


Figure 10. A map over the shale field in Östergötland (area 480 km^2 , thickness 15 m, total shale quantity approximately $7 \cdot 10^9 \text{ m}^3$, oil content approximately 4%, thermal value 1600 kcal/kg): the extractable calorie amount corresponds to approximately 1000 million m^3 oil.

IN SITU RESISTIVE HEATING OF OIL SHALE FOR OIL PRODUCTION

A SUMMARY OF THE SWEDISH DATA

J. E. De Rouffignac

The Swedish Shale Oil Co. Ltd.

Location of plant: Kvantark, Sweden

- 1941-1943 : Research and field test (six inj. + two prod.)
- 1943-1946 : Pilot plant on a semi-full scale
(500,000 tons of shale total
= 120,000 barrels total)
- 1944-1947 : Expansion II. Full scale plant, stopped for lack of energy in Sweden
- 1952 - : Expansion III. Full scale

Expansions II and III produced 400,000 barrels of oil.

Physical properties of this oil shale

Average heat cond.:

Perpendicular: 1.25 mcal/cm · sec °C

Parallel: = 5.00 mcal/cm sec °C

Mean specific heat (0-400°C) = 0.33 kcal/kg · °C

= 0.33 Btu/lb · °F

Fisher oil yield 5.5-6.0% by weight = 15-16.5 G/ton

Shale seam = 17m, close to horizontal covered by 6-7m limestone cap.

Power consumption 6.4 kwh/liter of oil

Product Composition (Expansion II)

Gasoline	515 liters/m ²
Kerosene	160 liters/m ²
Fuel oil	<u>350 liters/m²</u>

Total oils 1025 liters/m²



Skifferoljefrågan

— gamla och nya synpunkter

Tekn. dr Fredrik Ljungström, Fiskebäckskil

665.452

662.747 6 : 662.67

De metoder, som under det gångna decenniet utvecklats inom Svenska Skifferolja AB för framställning av skifferolja och andra produkter, kan uppdelas i två grupper: brytningsmetoder och oljeframställning in situ. Under bolagets verksamhet har de förstnämnda åtnjutit statsmakternas helhjärtade stöd, vilket är glädjande, då framställningen av flytande bränslen ur landets egna resurser är av utomordentlig vikt.

På grund av ogynnsamma naturomständigheter har däremot icke den yngsta och nyaste metoden, framställningen in situ, kunnat ges ett motsvarande tillfälle till utveckling. Denna metod, den elektrotermiska skifferoljaframställningen, har framträtt först sedan Skifferoljebolaget bildades, under det att brytningsmetoderna i olika utformning förekommit redan innan mineraloljaindustrin i sin helhet fått den världsomfattande betydelse, som den numera har (i Skottland framställdes skifferolja innan annan mineralolja kommit i allmänt bruk).

Är med utpräglad vattenbrist har försvärat tillämpningen av den elektrotermiska metoden in situ och, vad värre är, under en följd av år in-

direkt stoppat utvecklingen av denna metod. Under den första efterkrigsperioden rann oljan från alla håll in i vårt land från de under kriget uppladdade lagren av olja, varvid den naturligen sökte sig den väg, där betalningen för tillfället fanns att hämta. Härigenom ställdes kraven på fortsatt drift med den elektrotermiska metoden i än ogynnsammare dager, och det blev nu omöjligt att fortsätta det utvecklingsarbete, som dithills från Vattenfallsstyrelsen rönt så mycken uppmuntran. Slutligen kunde trots mycket gynnsamma resultat knappast någon förhoppning kvarstå, att denna metod skulle kunna vidare utvecklas.

Det har därför legat nära till hands, att jag såsom varande initiativtagare skulle söka andra vägar för framställning av olja in situ, där beroendet av landets vattenkraft bleve mindre framträdande och där självförsörjningsprincipen kunde tillämpas. Redan för flera år sedan sökte jag därför intressera ett större industriföretag för att inom landet tillverka syrgas i större skala med ändamål att på skiffer tillämpa den redan i utlandet igångsatta utvecklingen av förgasning av kol in situ med användning av syrgas (Tekn. T. 1949 s. 842, 1950 s. 222).

Föredrag i Ingeniörsvetenskapsakademien den 23 februari 1950.

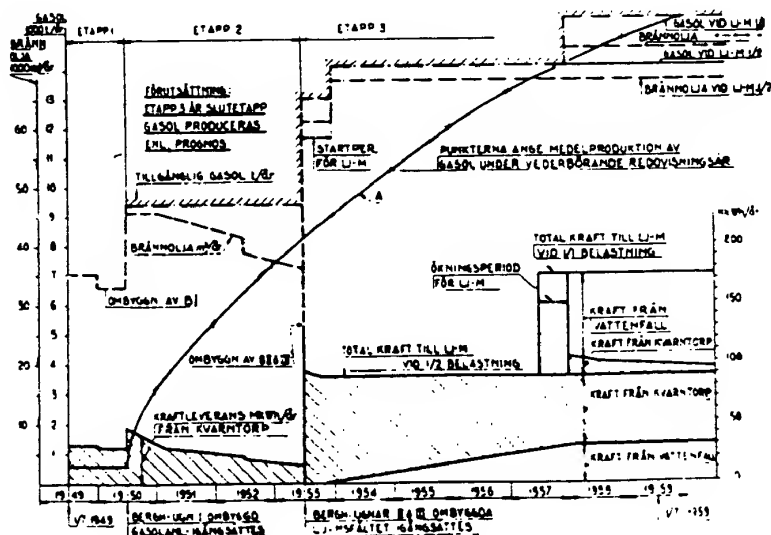


Fig. 1. Tidplan för Ljungströmsmetoden.

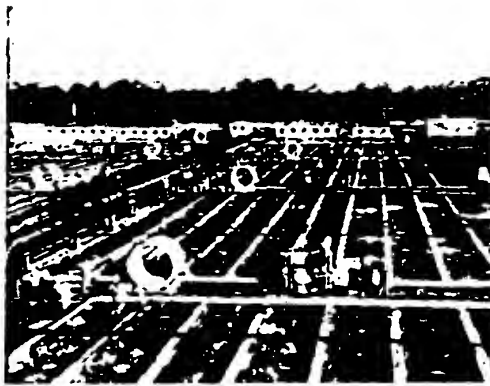


Fig. 2. Fältet Norrtorp 2, där 70 000 m³ Ljungströmsolja har utvunnits.

I Kvarntorp avses den elektrotermiska metoden, även kallad Ljungströmsmetoden, att åter sättas i gång först 1953, fig. 1, varefter gradvis vattenkraft kan inkopplas, så att slutligen omkring 20 MW kan tillföras anläggningen år 1958. Det må förläts mig, om detta utvecklingsprogram icke är alltför stimulerande för den 75-årige initiativtagaren, ehuru det för honom på samma gång är en tillfredsställelse att se, att hans initiativ åter kommer till användning och därvid förväntas avsevärt förbättra Skifferoljebolagets ekonomi.

Erfarenheter från driften vid Kvarntorp

Vid den nu nedlagda driften på fältet Norrtorp 2, fig. 2, närmade sig under något år inmatningen av elektrisk energi i genomsnitt 20 MW fördelade på två fronter med 10 MW i vardera fronten;

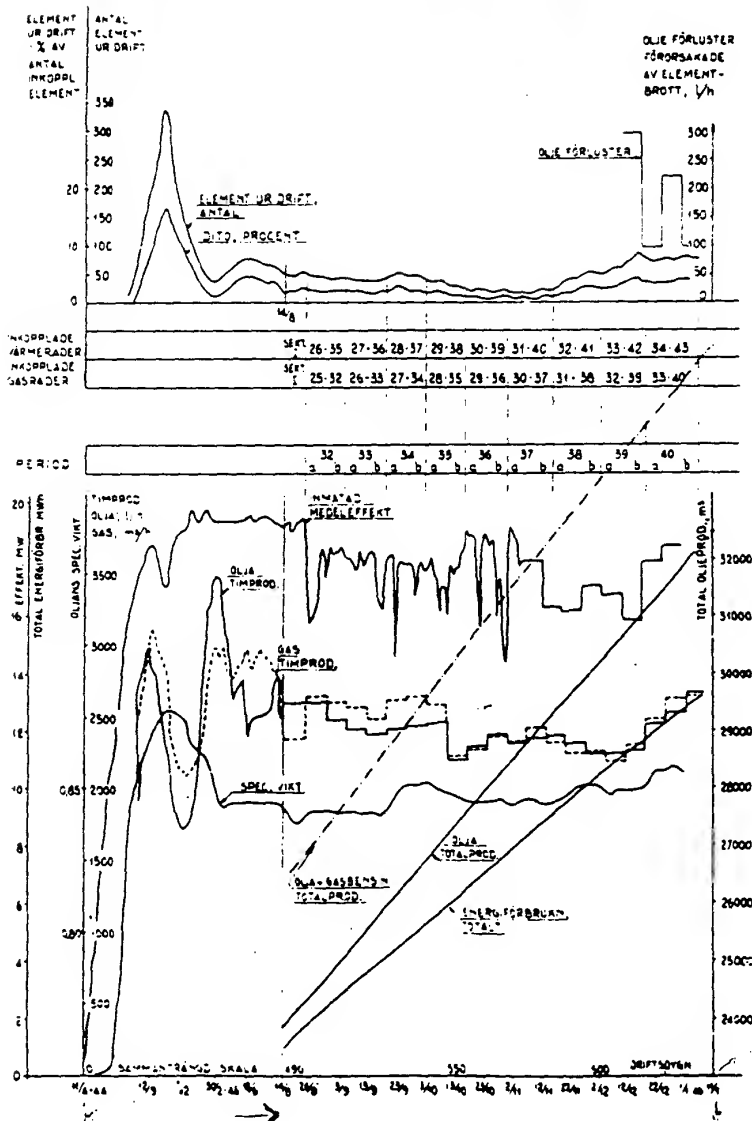


Fig. 3. Driftstatistik från Norrtorp 2.